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**United States Patent** [19][11] **Patent Number:** **5,089,711****Morsell et al.**[45] **Date of Patent:** **Feb. 18, 1992****[54] LASER PLASMA X-RAY SOURCE****[75] Inventors:** **Arthur L. Morsell**, Del Mar; **Henry Shields**, San Diego, both of Calif.**[73] Assignee:** **California Jamar, Incorporated**, San Diego, Calif.**[21] Appl. No.:** **627,210****[22] Filed:** **Dec. 13, 1990****Related U.S. Application Data****[63]** Continuation of Ser. No. 467,779, Jan. 19, 1990, Pat. No. 5,003,543.**[51] Int. Cl.<sup>5</sup>** ..... **G03B 41/16****[52] U.S. Cl.** ..... **250/492.3; 250/493.1****[58] Field of Search** ..... **372/5; 250/492.21, 493****[56] References Cited****U.S. PATENT DOCUMENTS**

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**[57]****ABSTRACT**

A laser plasma X-ray source for use in photolithography is disclosed wherein an electro-optical shutter is used to trim the output pulse from a master oscillator to a desired duration. The pulse is then split into several pieces which travel along various optical delay paths so that the pieces pass sequentially through a laser power amplifier. After amplification, the pieces are reassembled and then focussed at the plasma target. In a first embodiment, polarization and angle coding methods are used to distinguish each pulse piece at it travels along the delay paths. In a second embodiment, polarization coding is replaced by additional angle coding transverse to the plane of the angles of the first embodiment. An expander/reducer lens assembly is used in both embodiments to reduce the angles between the beam paths and allow more beams to fit closely to the laser amplifier gain region.

**35 Claims, 11 Drawing Sheets**